ENERGY USE ENGINEERING DEPARTMENT

ENERGY MANAGEMENT DIVISION

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Information includes electric and gas load characteristics, efficiencies, operating costs, performance and economies; usage trends, trade and industry practice, equipment availability and developing business opportunities; codes and standards; the potential impacts of energy management, alternative services and marketing activities; and customer needs, alternatives and preferences.

The service is provide by a team supervised as follows:

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***ELECTRICAL AND GAS TECHNOLOGIES AND ELECTRIC & GAS INDUSTRIAL APPLICATIONS** (including associated total-energy, district and waste energy applications; electric and gas vehicles, power factor and demand control)	**G.D.A. Henriques, P.Eng.**	(663-3286)
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INDUSTRIAL ENERGY USE

THE PULP AND PAPER INDUSTRY

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INDUSTRIAL ENERGY USE:
THE PULP AND PAPER INDUSTRY

INTRODUCTION

This presentation will indicate energy use patterns in the industry today and show how these are expected to change in the coming years. The total energy used in the pulp and paper industry and the percentages of different forms of energy at the beginning and end of the last decade are reviewed, and the reasons behind the changes discussed. Some of the electricity intensity information presented applies across Canada but the majority is taken from studies of the B. C. Industry conducted recently.

The Pulp and Paper Industry is the largest industrial electrical consumer in Canada, purchasing nearly 30,000 GW.h in 1983, or 38% of the industrial electrical consumption. (Figure 1)

The total 1983 pulp and paper production amounted to 21.5 million metric tonnes thus giving an average electricity consumption of 1395 kW.h per tonne of product. (Figure 2)

The following chart shows the change in the proportions of purchased energy between 1972 and 1983. Electricity's share has increased from 24.1% in 1972 to 36% in 1983, with a corresponding decrease in residual oil from 48.4% in 1972 to 32.2% in 1983. (Figure 3)

The use of biomass (hogged fuel and black liquors recovered from the Kraft process) in the industry doubled between 1972 and 1983. The share of biomass now makes up 64% of the total fuel compared to 48% in 1972. (Figure 4)

The industry suffered severely in 1981 and 1982 and operated at about 80% capacity. Increased production in 1983 raised operating levels to between 90 and 95%. Cost reduction continues to be the key priority in the industry's efforts to improve its competitive position in the world pulp and paper markets as lower quality lower priced pulp is being produced in South America. The reduction in purchased energy and energy conservation targets are essential components of this endeavour.

Pulp & Paper Processes

The products manufactured by the pulp and paper industry may be divided into two main categories:

pulps
paper and packaging products

Pulps are the first products produced from wood in the manufacture of all grades of paper and packaging products. The de-liquified cellulosic fibers are recovered by mechanical or chemical means. Various degrees of bleaching are performed depending on the colour and quality of the secondary product.

Chemical Pulps

Chemical pulps are produced by cooking the chips in a pressure vessel with chemicals and steam. The predominant chemical process, representing over 95% of the chemical pulp production, is the kraft process, (also known as the sulphate process) which produces a strong dark coloured pulp suitable for many types of paper. The other principal chemical process is the sulphite process which produces a weaker but less coloured pulp particularly suitable for printing grades of paper. Yield of chemical pulp is of the order of 35 to 57% and is considered low.

The main chemical processes are: (Figure 5)

- unbleached kraft
- semi-bleached kraft
- bleached kraft

Mechanical Pulps

Mechanical pulps are designated by the refining or grinding processes used for their production. Types of mechanical pulp include stone groundwood (SGWD), thermo-mechanical (TMP), chemi-thermo mechanical (CTMP) and refiner mechanical (RMP). (Figure 6)

Paper & Packaging Products

Papers and other secondary products such as newsprint, printing paper, linerboard, fine paper, tissue and paperboard are produced by blending suitable grades and colours of pulp with nonfibrous additives.

ELECTRICAL ENERGY USE

Chemical pulps typically use about 600-930 kW.h of electricity per tonne of pulp produced, depending on the age of the plant and on the process and equipment efficiencies. (Figure 7) Un-bleached chemical pulps will use less than 600 kW.h/tonne.

Mechanical pulps require anywhere from 1510 - 2400 kW.h of electricity per tonne of pulp produced. The range of figures relate to stoneground wood, TMP/RMP and chemi-thermomechanical pulp. (Figure 8)

Paper and paper products require between 600 and 1200 kW.h of electricity per tonne of production in addition to the electrical energy used for pulping. (Figure 9)

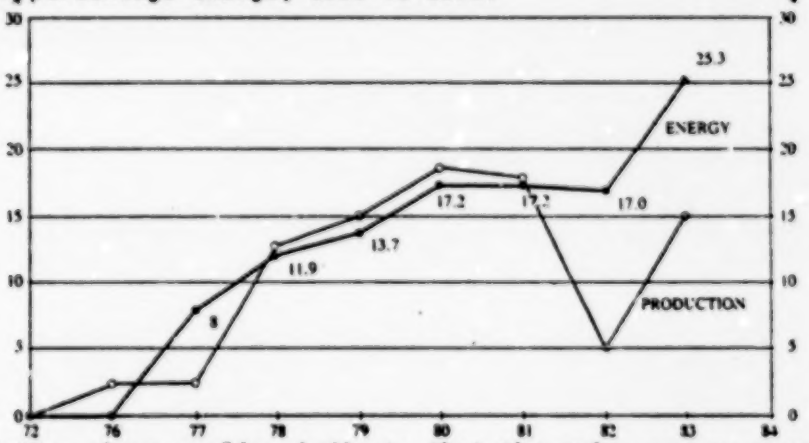
Projections of energy use in the pulp and paper industry based on historical data could be entirely misleading. To project energy use with a high degree of reliability, it is essential that projections for all pulp and paper products be made first. By combining this information with the respective energy intensities and by making allowances for the plants age and type of equipment, more realistic values will result.

EFFECTS OF ENERGY CONSERVATION

In 1975, as a result of a federal government "initiative", the Canadian Industry Program for Energy Conservation was established. A number of task groups were formed with member companies from industry accounting for more than 85% of industry's energy consumption. The purpose of the groups was to collect base energy consumption data, set long-term energy conservation targets, and monitor and report on progress.

The 1983 Report from the Energy Steering Committee of the Canadian Pulp and Paper Association stated that purchased energy had been reduced by 25.3%, compared with the equivalent 1972 usage, or only 4.7% below the 30% target set for the end of 1984.

The graphs below show the energy use efficiency improvements and production, percentage change, 1983 vs 1972.



The statistics shown earlier indicate that the major energy conservation targets have been met essentially.

Estimates of conservation potential take into account the following kinds of energy saving activities:

(a) Efficiency improvements of existing electric energy-using processes. Quantifying this potential requires estimating electricity use by process and making some estimate as to potential savings by process.

(b) Displacement of purchased electricity by self-generation.

(c) Improvements in plant lighting systems.

Estimates of energy conservation potential have a fairly good degree of reliability. Since implementation rates are uncertain, however, projections of energy use will also be uncertain. Furthermore, pulp and paper manufacturers may be more concerned about saving oil and gas than electricity, and possibly willing to trade off oil and gas consumption for higher electricity consumption. The extent to which this may occur will depend on production possibilities and relative prices of oil, gas, electricity, and other inputs.

The main areas in which electrical energy savings can best be made relate to electric motors, pump efficiency improvements, motor load operation, cogeneration and lighting.

Electric Motors

Electric motor drives account for 90-95% of pulp mill electricity use. The potential electricity savings attributable to the installation of energy efficient motors used for mechanical drives is 1.5%. This number is conservative because motors in the paper industry are predominantly large in size and large motors are not subject to significant efficiency improvements. Because such motors are seldom replaced, the potential is restricted to new motors only.

Pump Efficiency Improvements

The significant pumping loads may be amenable to electric energy efficiency improvements. It is estimated that the potential savings may be on the order of 2.3% for pumping. This percentage saving is applicable to new pumping loads and the replacement of existing pumps. These improvements are usually achieved because of more careful design techniques of the equipment components.

Motor-Load System Improvements

The potential for system improvements depends on the variability of loads on the motors. Generally, the more variable loads are, the greater the inefficiencies and the higher the potential for electricity savings.

In the absence of specific data, it has been assumed that the potential savings from motor system improvements and variable speed control technologies are equal to the sum of the potential intensive efficiency improvements for motors and pumps. This is 3.8% and is assumed applicable to new motor drives only.

Cogeneration

The potential for cogeneration in B. C. would appear to have been largely realized. Thus, any estimate of purchased power reduction due to cogeneration could well be conjecture at present.

Lighting Improvements

Lighting annually accounts for up to 5% of pulp and paper mill electricity use. The installation of higher efficiency lighting systems, such as high-pressure sodium and/or metal halide, and better control systems can reduce electricity use for lighting by up to 20% (i.e. a reduction of 1% in mill electricity use).

Summary of Conservation

The estimated overall weighted average energy savings due to improvements in electric motor drive, pumping and motor load operation are 4%. For lighting, an additional 1% saving may be added to this figure.

ADDITIONAL USAGE

As the pulp and paper industry strives to improve process efficiencies and productivities, new technologies requiring a larger share of electrical energy are expected.

Paper Machines

Future paper machines will consume more energy per tonne of product (estimated at 10%) due to lower basis weights and larger paper machine vacuum pumps (the major consumer of energy on a paper machine).

Newsprint

MacMillan Bloedel have developed a process in newsprint manufacturing which could eliminate the 15% kraft pulp added to thermomechanical pulp (TMP) in newsprint furnish. Details of the process have not been published, but the 200 TPD prototype facility to be installed in Powell River is expected to be fully operational by 1986. This process will evidently increase the demand for TMP with attendant electricity requirements.

There is a trend towards increased proportions of TMP in newsprint pulp furnish. As TMP has a high electricity intensity ratio, the intensity for the furnish (ingredients used in the manufacture) will be proportionately higher. The effect of furnish composition on energy intensity is illustrated in the table below, which shows that the pulp with the highest percentage of TMP (Furnish C) has the highest energy intensity (2300 kW.h/tonne). (Figure 10)

	Furnish Composition		
Newsprint Pulp Component	Furnish A	Furnish B	Furnish C
Stoneground wood (SGW)-%	80	59	12
Semi-bleached kraft (SBK)-%	20	14	-
Thermomechanical (TMP)-%	-	27	88
Energy intensity - kW.h/tonne	1350	1650	2300

Mechanical Pulping

Pulp and Paper International reports that 17% of Canada's mechanical pulp production capacity is TMP and 8% is refiner mechanical pulp (RMP). There is a reported trend to convert RMP plants to TMP, and all Canada's growth in mechanical pulping will be in TMP, up by 50% (nearly 30% of overall mechanical grade capacity by 1984).

In addition to the increased use of TMP as a pulp component, as discussed above, an increase in the production of specialty grades of newsprint is anticipated. (By 1990, specialty grades will, reportedly, represent 30% or more of Canada's newsprint production.) These upgraded newsprint products require an improved quality of mechanical pulp. The additional processing required to improve pulp quality necessitates an increase in pulp electricity intensity which could be as high as 40%.

Vapour Recompression

Vapour recompression is an energy conservation technique in which the amount of steam required to be generated from a boiler is reduced through recompression of low pressure exhaust steam. (Roughly, some 20 units of boiler fuel energy are replaced by 1 unit of electrical energy used to drive a compressor.) The implementation of this technology can thus result in an increase in electricity use.

In the kraft (chemical) process of pulp manufacture, vapour recompression is recognized as a potential means of improving evaporation efficiency. It would be conjecture to relate the associated additional electricity use to purchased power, however, mainly because of the apparent limited future of kraft processing and the high proportion of self-generated power in kraft mills.

Approximately 90% of the electrical energy input to TMP refiner motors ends up generating steam. Following countless attempts at effecting significant reductions in energy demand by new designs of refiner plates, technologists have, in the last 3-5 years, turned their attention to the more readily achievable goal of generated steam recovery.

It is now considered feasible to manufacture newsprint from TMP without the need for a separate boiler for steam production to be used in the paper machine dryer section. In many cases, the steam pressure generated from the TMP processes are sufficiently high, and recompression is not necessary.

Thus, vapour recompression in the TMP process may find limited applications. Under these circumstances, the additional attributable electricity load would not be a major item.

SUMMARY

Based on an assessment of pulp and paper manufacturing processes the range of the electrical energy content for chemical pulp will remain between 600 and 930 kW.h/ADT; for other pulp and paper products will remain between 600 and 1200 kW.h/ADT; and mechanical pulps will experience a net increase of about 6% after accounting for energy conservation. The mechanical pulps will use between 1600 and 2550 kW.h/ADT. The net increase in the electrical content will result from the use of electrically driven heat pumps for waste heat recovery to offset fossil fuel usage (mainly oil and natural gas).

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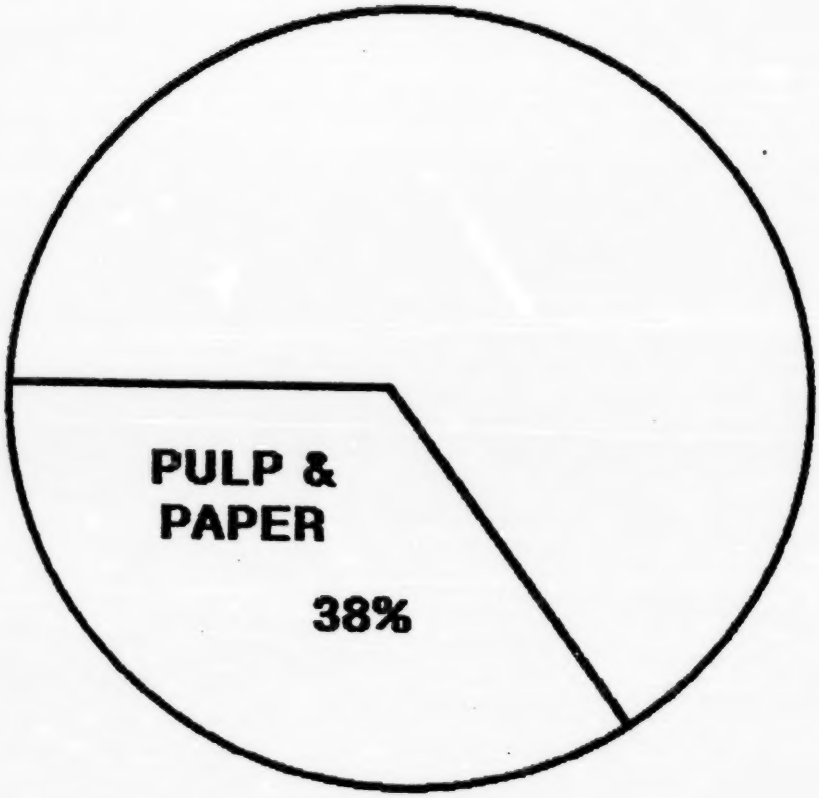


INDUSTRIAL ELECTRICITY CONSUMPTION

78,200 GW.h[1] in 1983

[1] *Canadian Industry Program for Energy Conservation, 1983 Report*

FIGURE 1

PULP AND PAPER

21.5 MILLION TONNES

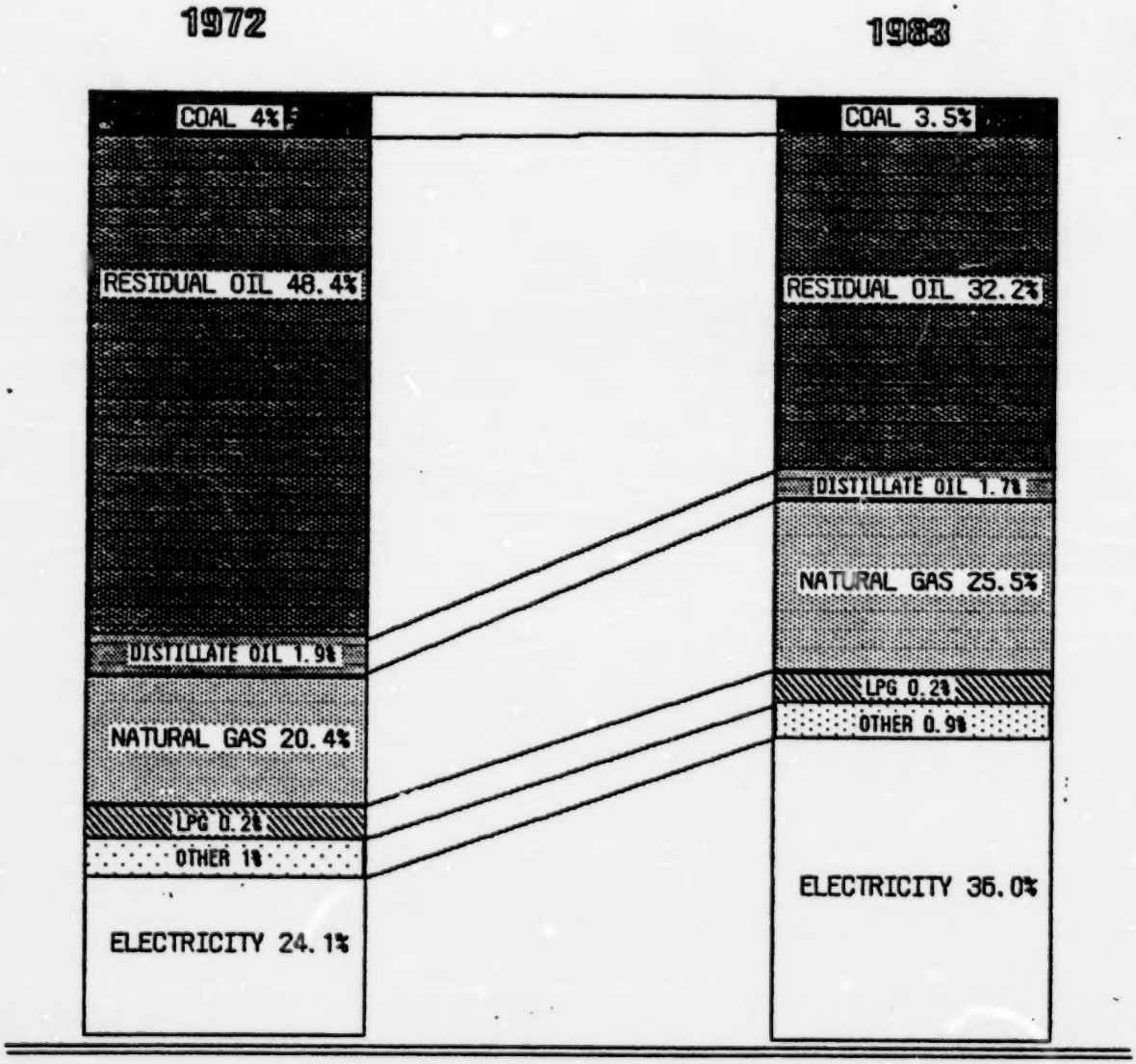
30,000 MILLION kW.h

1395 kW.h/TONNE

Canadian Industry Program for Energy Conservation, 1983 Report

FIGURE 2

PULP & PAPER INDUSTRY
PURCHASED ENERGY



CANADIAN INDUSTRY PROGRAM FOR ENERGY CONSERVATION, 1983 REPORT

FIGURE 3

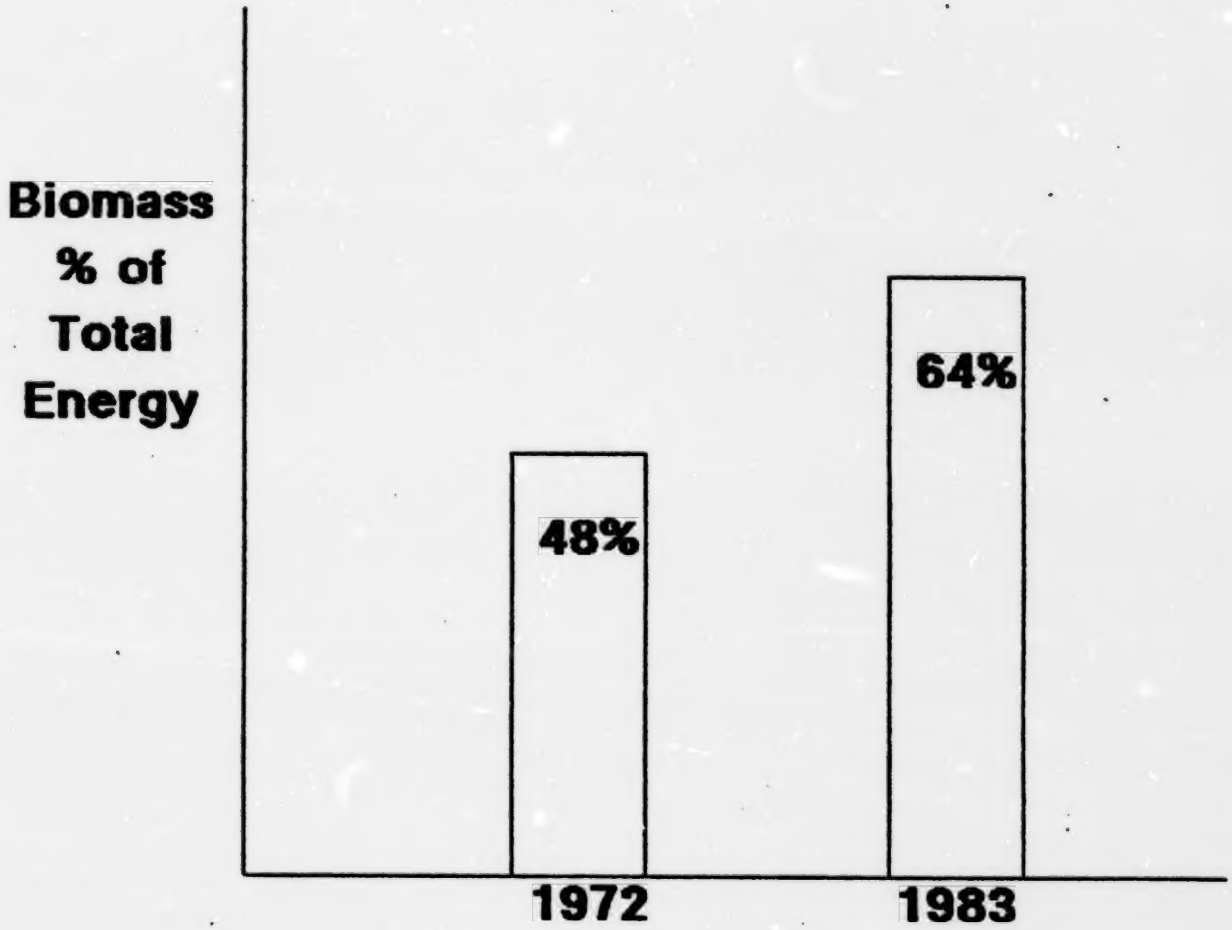


FIGURE 4

CHEMICAL PROCESSES

* UNBLEACHED KRAFT PULP (UBKP)

* SEMI—BLEACHED KRAFT PULP (SEMI BKP)

* BLEACHED KRAFT PULP (BKP)

FIGURE 5

MECHANICAL PROCESSES

* STONEGROUND WOOD (SGWD)

* THERMO–MECHANICAL PULP (TMP)

* CHEMI–THERMO–MECHANICAL PULP (CTMP)

* REFINER MECHANICAL PULP (RMP)

FIGURE 6

CHEMICAL PULP

Type	kW.h/Air Dried Metric Tonne (ADMT)	
	Current Plant	Future Plant
UBKP	600	600
SEMI BKP	600—665	600—665
BKP	600—930	600—930

FIGURE 7

MECHANICAL PULP

Type	kW.h/Air Dried Metric Tonne (ADMT)	
	Current Plant	Future Plant
SGWD	1510—2000	2150
TMP	1800—2400	2100—2400
CTMP	2150	2050—2150
RMP	1665—2000	1600—1900

FIGURE 8

PAPER AND PAPER PRODUCTS

TYPE	kW.h/Air Dried Metric Tonne (ADMT)	
	Current Plant	Future Plant
NEWSPRINT (only)	600—650	660—700

FIGURE 9

NEWSPRINT

COMPONENT	FURNISH COMPOSITION		
	A	B	C
Stoneground wood (SGW) %	80	59	12
Semi—bleached kraft (SBK) %	20	14	—
Thermo—mechanical (TMP) %	—	27	88
Energy Intensity kW.h/tonne	1350	1650	2300

FIGURE 10